RITE-MT

(Return on Investment Tool for Effective Medical Training)

FINAL REPORT

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14. DISTRIBUTION

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Nontechnical reports may be provided in contractor format. Technical reports shall be in the format described in paragraph 1 of Section H. Must include contract number, project title, total contract amount, costs incurred during the performance period, costs incurred to date, estimate to complete, schedule of deliveries or milestones, actual dates of delivery or completion of milestone, brief summary of progress and major accomplishments, explanation of any anticipated problems and actions being taken to correct problems.

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A002	Final Report		

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Block 11: The final report shall be delivered no later than the end date specified in Section F of the Contract.

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE
Dr. Ray Perez	12 Mar 2013	Russelle Dunson	15 JUL 2013

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14. ABSTRACT
The Return on Investment Tool for Effective Medical Training (RITE-MT) effort sought to develop a decision-support software tool to assess Return on Training Investment (ROTI) by looking at cost, schedule and training performance benefit throughout the training system lifecycle. This includes quantifying the gains achieved in training effectiveness and efficiency. The result of this effort was the development of the Evaluation of Value Added in Learning Systems-RITE-MT (EVALS-R) tool. EVALS-R provides a training needs-based methodology (TNM) within a network-capable software system guided by user validated interfaces. The TNM guides users in identifying fidelity requirements necessary meet target training objectives and evaluate training systems for their capability to support this. EVALS-R provide users with an interactive Return on Training Investment analysis that can be used to weigh performance improvements versus long-term costs and allow users to identify the most cost-effective system that meets task training objectives/training needs.

15. SUBJECT TERMS
Return on Training Investment, Return on Investment, Simulation, Training Effectiveness Evaluation

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 SUMMARY

As combat operations draw down and budgets become tight, military decision makers are faced with difficult decisions regarding how to allocate resources. Decision makers seek quantifiable evidence to justify any investment, and investing in training is no exception. Training system return on training investment (ROTI) is rarely calculated even though it can reveal significant insight regarding the cost, schedule and training performance capabilities of these systems. Optimizing ROTI can yield significant savings in costs associated with reduction in training time and a decrease in instructor resources or compression of the time necessary to produce levels of expertise (Cohn and Fletcher, 2010). Part of the reason these types of analyses are not conducted is their resource intensiveness, lack of standardized methodologies and limitations on data to make calculations. What is needed is a standardized ROTI method and tool which is accessible, easy to use, and generalizable across domains. Under the RITE-MT effort, the Evaluation of Value Added in Learning Systems-RITE-MT (EVALS-R) tool, a decision support tool for ROTI analysis, was developed to address this gap by utilizing a Training Needs Analysis (TNA)-based approach which incorporates the quantification of performance (i.e., training effectiveness) gains with respect to target training objectives, and lifecycle cost and schedule impacts. EVALS-R 1) provides an analysis of a training system's ability to meet training goals, within the budgetary and schedule constraints set forth by the organization, and 2) facilitates return on investment tradeoff analyses both within a system (e.g., which specifications justify their cost) and across systems (e.g., which systems provide the most "bang for the buck"), resulting in increased organizational training and readiness. To accomplish this, the RITE-MT effort completed the following objectives:

Objective 1: Plan EVALS-R Effectiveness Evaluation
Objective 2: Define EVALS-R Requirements and Specifications
Objective 3: Conduct Detailed Design
Objective 4: Develop Prototype Software
Objective 5: Conduct Verification and Validation
Objective 6: Design-Code-Test Version 2.0
Objective 7: Perform EVALS-R Effectiveness Evaluation
Objective 8: Develop Commercial Production and Distribution Plan

2.0 INTRODUCTION

The Evaluation of Value Added in Learning Systems-RITE-MT (EVALS-R) was developed under this effort using an agile software development process to expedite the design-development-evaluation cycle and integrate greater flexibility into the direction of the systems design. This process allowed for iterative functional testing, redesign requirements definition, and implementation of prototype development changes within each version of the system, and quicker integration of feedback and adjustments to the system's design. Though user needs identification, requirements development, and detailed design were largely completed before prototype development began, the agile software development process employed allowed revisions to the design as needs were identified. This increased the efficiency of development by allowing for bugs to be identified and mitigated quicker (while they still have minimal impact on the software), allowing for extra functionality to be developed in each version in the time that would normally be spent fixing bugs. Initial user needs identification and preliminary testing

with interface designs were done with subject matter experts (SMEs) from the Nicholson Center at Florida Hospital and Project Manager Training Devices (PMTRADE). Additional redesign requirements were determined from usability testing of different versions of the system with SMEs from Project Manager Training Systems (PM TRASYS), other acquisition professionals, and human factors engineers.

3.0 METHODS, ASSUMPTIONS AND PROCEDURES

During the period of performance, Objectives 1-8 were completed, beginning with the development of the effectiveness evaluation plan and submission to the Institutional Review Board (IRB) for approval, followed by identification of user needs during subject matter expert (SME) interviews with SMEs from the Nicholson Center at Florida Hospital and from PMTRADE to revise the concept designed in Phase I. Then requirements and specifications were developed for the EVALS-R software tool, including use cases of how the tool will be used. These requirements led to the creation of a detailed design of the system, including the overall architecture, information flow, and graphical user interfaces (GUI). An agile software development process was employed while developing each version of the software to allow for the flexibility to iteratively test and implement changes, increasing the efficiency of development and increasing the amount of functionality able to be included. Usability testing of the different versions with different potential end users, including an acquisitions professional from PM TRASYS, resulted in redesign requirements that were incorporated into the following versions, resulting in a final version with minimal usability issues. Finally the commercial production and distribution plan was developed.

3.1 Objective 1. Plan RITE-MT Effectiveness Evaluation

The protocol for the effectiveness evaluation was developed and submitted for IRB review. Approval was received on September 18, 2013.

3.2 Objective 2. Define RITE-MT Requirements and Specifications

The system requirements for the RITE-MT (EVALS-R) system were developed based on the user needs gathered. The requirements were then reviewed by the software development team, and revisions were made in the final version based on their feedback.

3.3 Objective 3. Conduct Detailed Design

The design of both information flow and the overall the architecture of the system as well as the design of all of the Graphical User Interfaces (GUIs) was completed based on the use case designs and interactively improved through redesigns following feedback or evaluations. These designs were shown to potential end users (both government acquisitions SMEs and a commercial medical training SME) and feedback was incorporated into revised designs before development of the system prototype began.

3.4 Objective 4. Develop Prototype Software

With a better understanding of the scope of the effort based on the conceptual refinements, a software development plan was put together to ensure that the software development goals would be obtained within the schedule and budgetary constraints of the Phase II effort. An agile

software development process was used to develop the components of the EVALS-R system which resulted in three comprehensive versions being developed and improved upon throughout Phase II.

3.5 Objective 5. Conduct Verification and Validation (V&V)

Testing of the software application was conducted throughout the agile development process. Performance was tested against functionality defined in the requirements and use case documents to ensure the system contained the desired capabilities.

3.6 Objective 6. Design-Code-Test Version

Testing ensured the delivered system contain no major errors or undesired effects (i.e., “bugs”). This process was conducted throughout the agile development process.

3.7 Objective 7. Perform RITE-MT Effectiveness Evaluation

The effectiveness evaluation of the EVALS-R system focused on ensuring adequate end-user interaction and task support (i.e., usability) as per direction of the project’s sponsor (COR in a personal communication). This evaluation was conducted with 10 individuals who represented potential end users (e.g., two SME with 10 and 35 years of acquisitions experience respectively, and 8 others with various years of human-systems integration experience). Usability findings were mostly positive, with a few issues that were addressed via redesign of some of the interfaces.

3.8 Objective 8. Develop Commercial Product and Distribution Plan

Preparation of regression testing of the EVALS-R system was conducted to ensure the system’s readiness for release. A user manual was developed and can be found in the help section of the software. The system was also demonstrated to multiple potential customers, with the most interest from PM TRASYS, who provided a letter of support for a Rapid Innovation Fund white paper that was submitted but not accepted. Through evaluation and reviews with PM TRASYS, additional system capabilities / requirements were identified which would be outside the scope of Phase II efforts Therefore, alternative potential funding opportunities are being sought to tailor the EVALS-R system to their needs.

4.0 RESULTS AND DISCUSSION

4.1 Evaluation of Value Added In Learning Systems-RITE-MT (EVALS-R) Tool

The primary result of this Phase II effort was the development and validation of the EVALS-R system. This was the result of the evolution of the Phase I design which incorporated a review of the return on training investment literature, interviews with SMEs and prototype designs. During Phase II, additional front-end analysis was conducted to expand on the Phase I findings primarily by seeking input from potential transition customers and SMEs from both private and government sources (e.g., PMTRADE, PM TRASYS, Nicholson Center for Surgical Advancement at Florida Hospital). This insight was integrated into the conceptual and detailed design of the EVALS-R system, which was then integrated into a development plan.

EVALS-R offers a number of key benefits to the training system acquisition community. Up until now, the use of ROTI analysis has been limited and non-standardized using decentralized processes mostly handled through multiple spreadsheets. This has presented challenges in reuse of data and general usability of the process, and has resulted in suboptimal use of resources or acquisition recommendations. EVALS-R addresses these challenges by providing:

- …a tool where standardized ROTI analyses may be conducted and stored.
- …a ROTI methodology that translates cost, schedule, and performance data into actionable data and score.
- …a tool where training domain (training requirements) and training system data may be stored for reuse at later times.
- …a network capable tool which can support multiple distributed users if so desired (standalone isolated setup within a local network is also supported).
- …sensory analysis-based diagnostic capabilities to understand the training capabilities of the systems under review.
- …a baseline system from which additional analytical capabilities and customization may be introduced.

The Phase II conceptual design of the EVALS-R system is illustrated in Figure 1 below. This conceptual design highlights the training-centered approach utilized within the EVALS-R system where the analysis on training investment is conducted with regards to the training capabilities of the evaluated system. The EVALS-R system is organized around four key main components of the system: 1) Training Domains, 2) Training Systems, 3) Evaluations, and 4) ROTI Analyses.

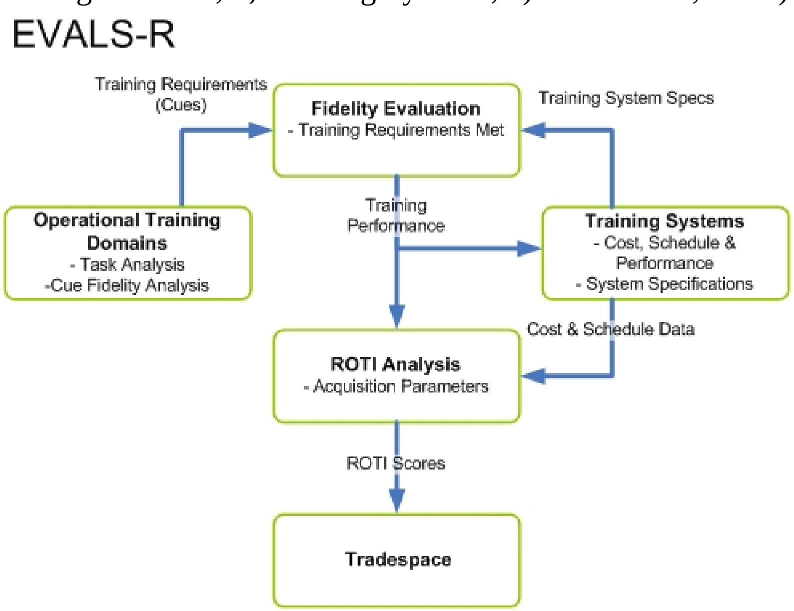

Figure 1. EVALS-R Conceptual Design

The *Training Domains* component (Figure 2) is a persistent library of operational training domains intended to grow with use of the system. Here users, usually operational domain SMEs, are guided through a characterization method to decompose training tasks and identify operational cue requirements (e.g., fidelity cue requirements).

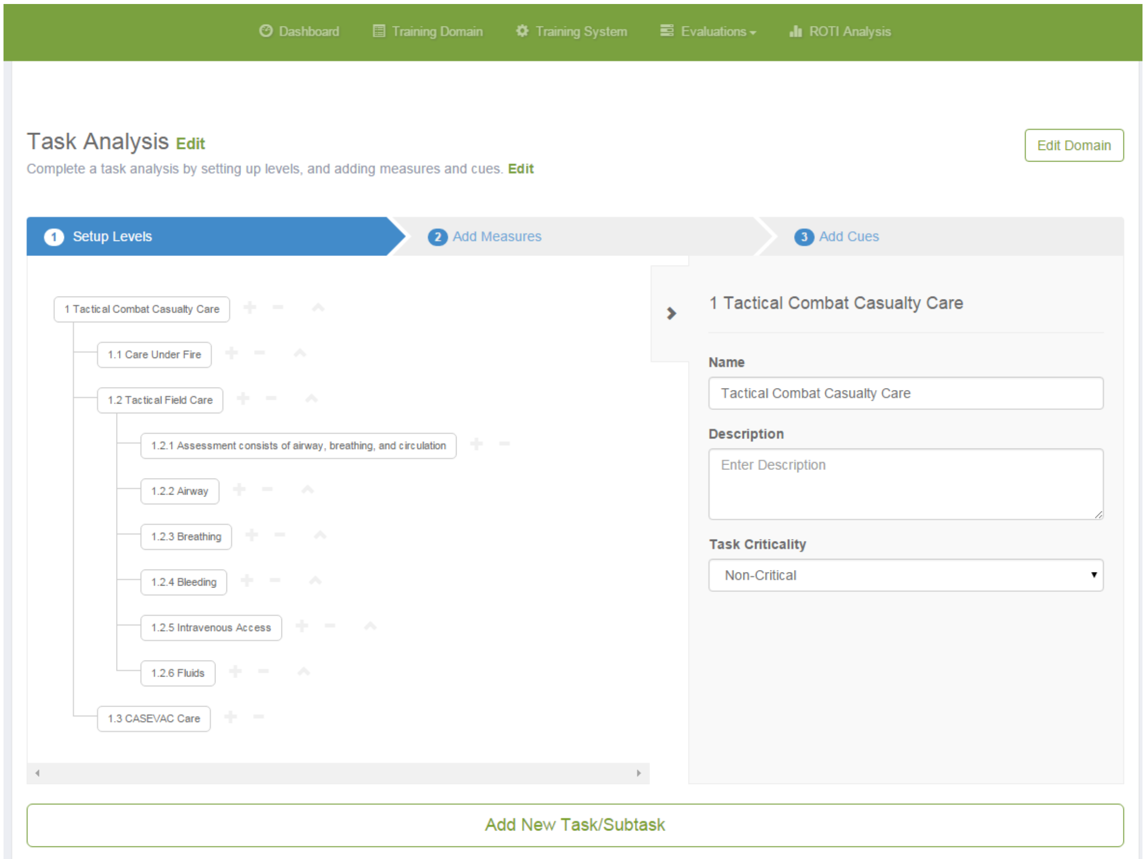

Figure 2. Training Domain Screen

The *Training Systems* component (Figure 3) is a persistent library of training systems that have been analysed or may be going through analysis. This component allows users to define training system characteristics such as cost, schedule, and system specification data as well as house historical training evaluation data.

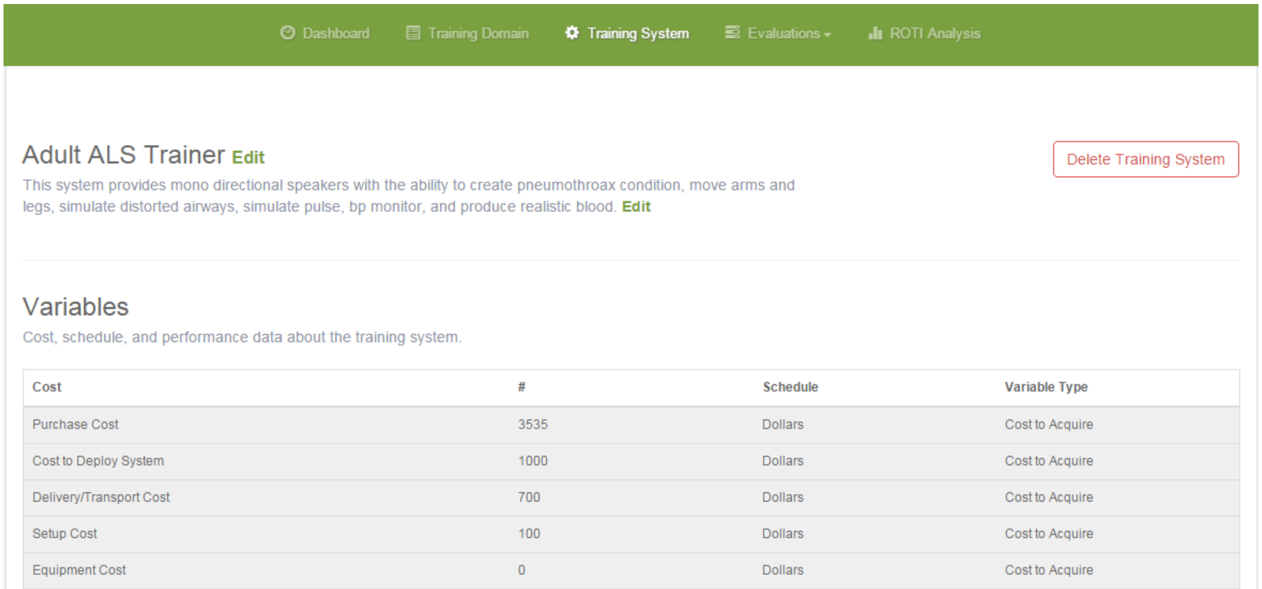

Figure 3. Training System Screen with Subset of Variables

Together data from both of these components is utilized to conduct a predictive training evaluation in the *Fidelity Evaluations* component (Figure 4), based on the training system's ability to support the identified required fidelity cues. This process may also be enhanced with empirical data with additional system capabilities beyond this Phase II effort.

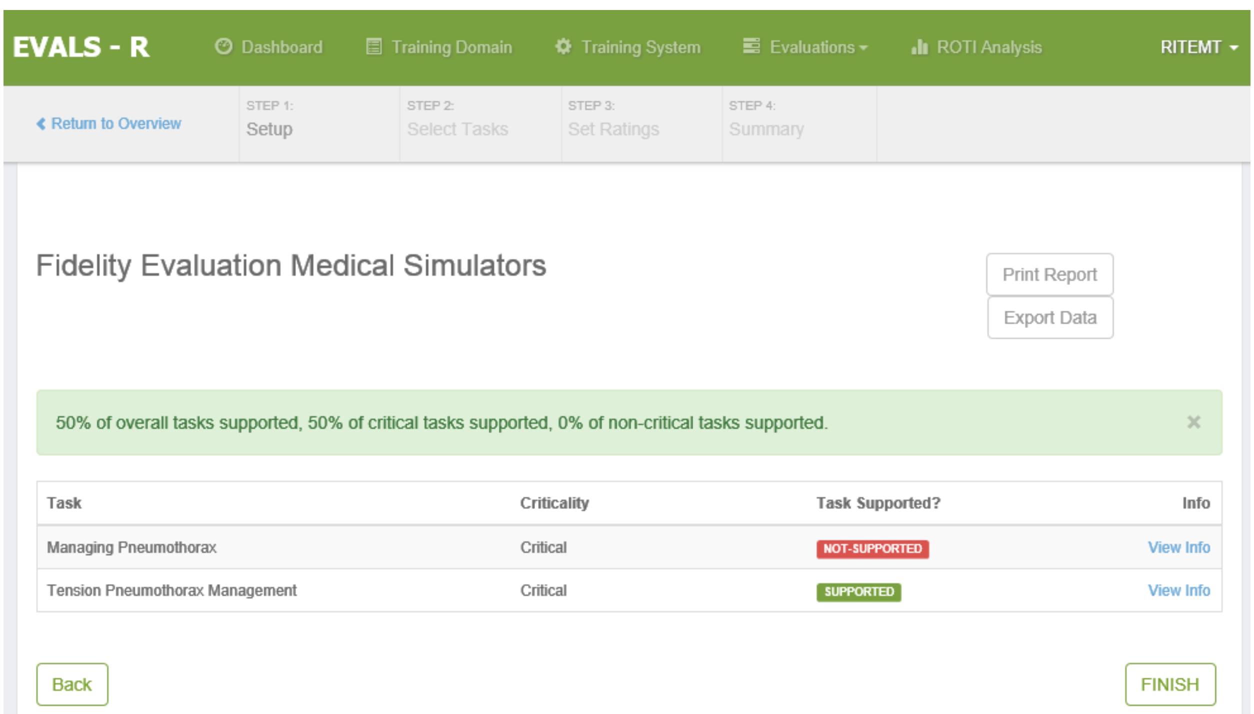

Figure 4. Fidelity Evaluation Results Screen

The results of the training evaluation plus cost and schedule data for a system under evaluation may then be fed into the *ROTI Analysis* component (Figure 5). The ROTI analysis component guides the user through defining a ROTI model which considers the cost, schedule, and training performance variables and their relative importance. The user may choose to include and weight the variables as best fitting the acquisition goals of the organization. Once the cost, schedule and training performance data is fed into the model, the system presents the ROTI results in the Tradespace output for review by the user. Within this output the user may choose to adjust parameters in the model to visualize the results (e.g., change cost or throughput values).

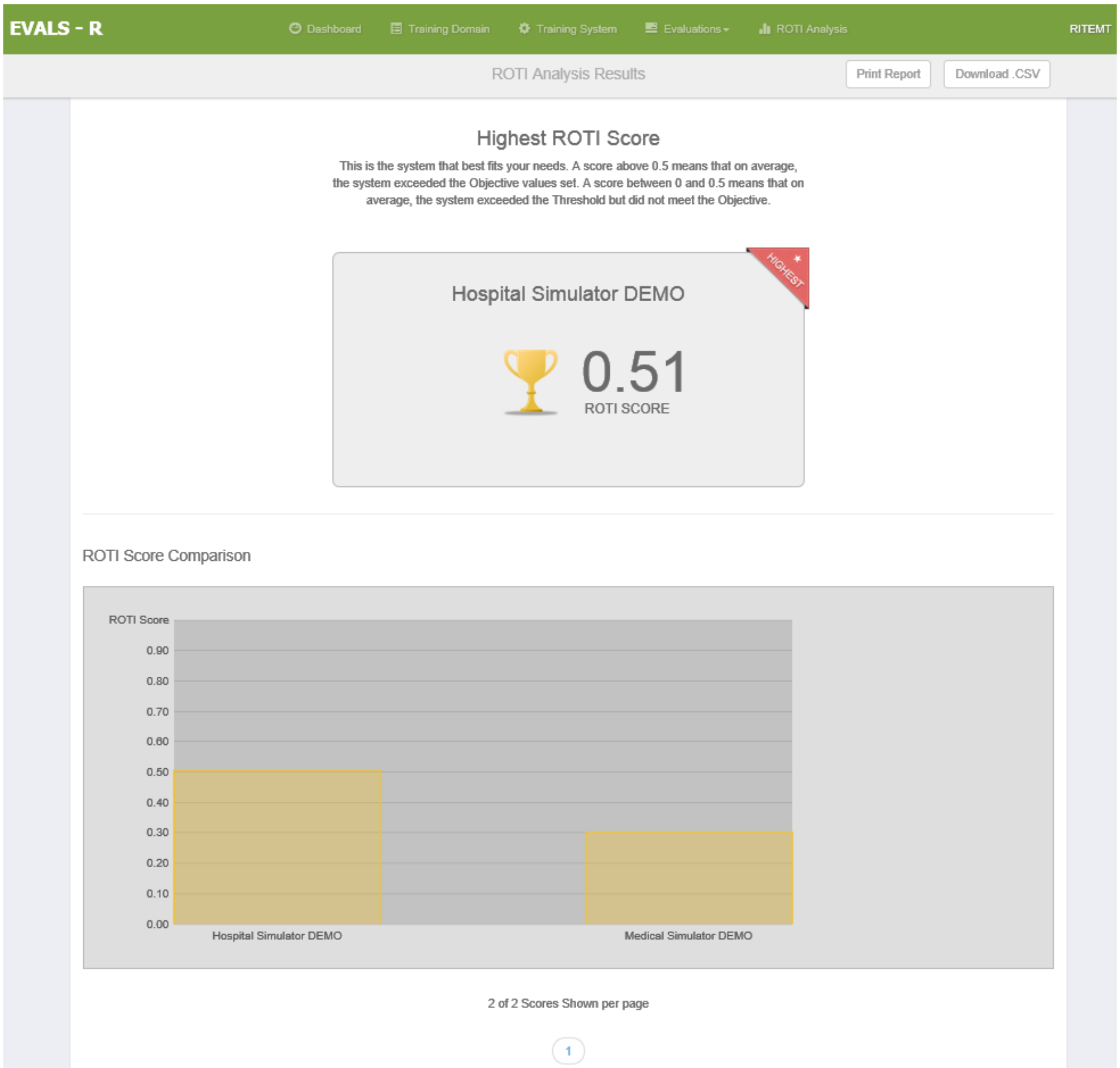

Figure 5. ROTI Analysis Results

4.2 Effectiveness Evaluation (Usability Testing and Redesign)

Throughout the Phase II effort, the EVALS-R system underwent usability focused evaluations involving both expert-based reviews (e.g., heuristic evaluations with wireframes, detailed GUI designs, or software GUIs) and empirical user testing with representative end-users. For this,

measures of task execution effectiveness, efficiency, errors and satisfaction were used to assess for potential usability concerns. Through this iterative process, usability concerns were identified and addressed as needed through redesign.

At the same time, summative measures of usability were utilized to understand the quality of the design as development progressed. For this the system usability scale (SUS, Brooke, 1996), and the Cooper-Harper subject workload scale (Cooper and Harper, 1969), an easy-to-use, validated workload scale which simplifies the workload construct into a single measure, and a measure of task utility were utilized. In total, 19 participants took part in these series of evaluations of the 3 major versions of the EVALS-R system. What follows is a summary of the observed results.

Usability: Participants answered a list of questions regarding usability using the Likert scale (1-Strongly Disagree and 5-Strongly Agree); grading was conducted using instructions provided in Brooke (1996). Table 1 summarizes these results where an overall increase in the SUS score was observed from the first to the last version developed in Phase II. The observed SUS score of 76.67 in V3.0 corresponds with high usability (Bangor, Kortum, & Miller, 2009; scores 68 and above usually correlate with systems that have high usability).

Table 1. Subjective Usability Scale Results

	V1.0 (n=9)		**V2.0 (n=6)**		**V3.0 (n=4)**		**ANOVA**	
Measure	**M**	**SD**	**M**	**SD**	**M**	**SD**	***F***	***P***
SUS (higher is better)	60.00	15.46	59.17	14.17	**76.67**	5.20	1.9	0.184

Workload: The Cooper-Harper scale utilizes two questions to determine the observed workload perceived by the user and the expected or desired level of workload and a 10-point scale (0–Completely undemanding, very relaxed and comfortable; 9 – Completely demanding). The results summarized in Table 2 show little variation in workload across the different versions. Such variations may be explained by the changes in design approach and incremental functionalities built across the three versions.

Table 2. Workload Results

	V1.0 (n=9)		**V2.0 (n=6)**		**V3.0 (n=4)**		**ANOVA**	
Measure	**M**	**SD**	**M**	**SD**	**M**	**SD**	***F***	***P***
Workload	0.24		2.00		**1.67**			
• Observed (0-9 response scale)	3.54	1.30	5.17	1.00	**4.67**	2.89	1.88	0.186
• Expected	3.30	1.13	3.17	1.53	**3.00**	0.00	0.08	0.923

Utility: As a measure of Utility, two questions using a 5-point Likert scale (1-strongly disagree to 5-strongly agree) were combined into a Net Utility score. This was a composite of how much value users believed the system added versus how much complication was created by the system. Table 3 summarizes these results: the Net utility score for the last version developed under Phase

II was 1.67 (sd: 1.15) of a possible range of -4 (where a system creates more complications than help) to 4 (where a system helps more than creates complications).

Table 3. Satisfaction and Utility Results

	V1.0 (n=9)		V2.0 (n=6)		V3.0 (n=4)		ANOVA	
Measure	**M**	**SD**	**M**	**SD**	**M**	**SD**	***F***	***P***
Net Utility Value	1.22	0.97	1.00	1.55	**1.67**	1.15	0.3	0.745
• System helps with tasks and responsibilities	3.44	0.73	3.00	1.26	**4.00**	1.00	1.08	0.366
• System complicates tasks and responsibilities	2.22	0.83	2.00	1.10	**2.33**	0.58	0.17	0.845

Together these results highlight the value added by the EVALS-R system by providing useful value with relative ease of use. These capabilities will serve training system acquisition, research professionals and subject matter experts without adding significant burden in its use.

4.3 Commercial Production and Distribution Plan

The EVALS-R system helps training system acquisition professionals who want to understand and optimize the return on training investment of systems they acquire. Government and private acquisition professionals working with large organizations are under increased pressure to cost-justify training system acquisition decisions, yet in the absence of a complete representation of the cost, schedule and training performance analysis model, such decisions may be suboptimal. Specifically, the EVALS-R system addresses common pain points or challenges existing in this work space, as shown below in Table 4.

Table 4. Benefits of EVALS-R

Current training system selection decision support challenges	EVALS-R
• …depend on decentralized spreadsheet based analysis methods focused on technical capability validation.	• …utilizes network capable technology to allow multidisciplinary teams work and manage ROTI assessments.
• …are technology centered, focus heavily on highest fidelity solution for lowest cost and instead of ensuring the system requirements justify their cost.	• …utilizes a training-needs centered approach to determine system requirements necessary to *train specific skill sets*.
• …focus heavily on traditional ROI metrics which limit the ability to quantify "soft" benefits such as training effectiveness.	• …extends ROTI to facilitate weighing the training benefit (training effectiveness) of the system against cost and schedule impacts
• …limit analysis of system requirements to those which impact training environment physical fidelity.	• …expands requirements analysis to incorporate functional fidelity and psychological fidelity.
• …are not practical for use under typical end user constraints (e.g., requires extensive expertise, time, and does not present the results in an easy to use format)..	• …employs wizard-type interface designs to guide users and presents results in a visual and interactive format which encourages iterative cost benefit trade-off analyses

The target markets for the EVALS-R system are government training acquisition offices and government laboratories given the budgetary pressures being placed on all agencies, particularly the Department of Defense Services which rely heavily on training. As budgetary pressures increase, the need to gain efficiencies on all fronts also increases, and as a result, more efficient and effective forms of training are required. Simulation-based training systems have been highlighted as a means by which greater efficiencies and training effectiveness may be achieved while at the same time reducing or eliminating risks. Nonetheless, the quality of these simulations is hard to quantify, particularly when evaluating their impact on training. This is because training effectiveness in itself is challenging to quantify, not only due to the resource-intensive nature of such evaluations but also because of the multiple methods which may be utilized. This compounds the challenge of accurately and objectively calculating meaningful ROTI analyses that not only focus on costs but also on time and training performance. EVALS-R

provides a solution to this challenge by providing a single tool to carry out all necessary sub-processes for calculating meaningful and objective ROTI analyses.

4.4 Technology Transfer

In order to ensure that the EVALS-R system is ready to be acquired by a customer, extensive testing was conducted, not only throughout the development process, but regression testing was also conducted at the end of the final development version. All major defects and usability issues were fixed, and the system was optimized to run as efficiently as possible. In addition, a user manual and installation materials were developed for delivery to customer.

Throughout Phase II, efforts to identify and transition the technology to customers have been conducted. Discussions with representatives from government agencies such as PM TRADE, PM TRASYS, and NAWCTSD have been pursued following demonstrations of the technology. In addition, private and academic organizations have been identified as additional potential transition customers. Discussions with a Research Hospital and Large DOD contractor have also been pursued in order to evaluate the technology and identify further uses. However, though feedback was positive and there was interest in acquisition in some cases, nothing has yet been able to be worked out. Therefore, transition leads continue to be pursued.

Further, a Phase II effort funded by the Air Force is currently underway, involving development of a software system to support a user in conducting different types of Training Effectiveness Evaluations (TEE; e.g. based on Fidelity Support, Subjective Reactions, and Learning Gains). Design Interactive Inc. developed this system's design to readily integrate with EVALS-R so that the training system performance data resulting from empirical TEEs can be pulled into the ROTI analysis to ensure that it includes the most recent and comprehensive training effectiveness data for each training system being compared. The combination of these two efforts allows EVALS-R users to conduct additional empirical TEEs, beyond the fidelity evaluation capability that is currently available, increasing the accuracy of the ROTI results.

5.0 CONCLUSIONS

This Phase II effort resulted in the development and validation of the Evaluation of Value Added in Learning Systems-RITE-MT (EVALS-R) tool, a decision support tool for the conduction of Return on Training Investment analysis by use by training development and acquisition professionals. EVALS-R provides these practitioners with the analytic capabilities to assess a training system's ability to meet training goals, within the budgetary and schedule constraints set forth by the organization, and facilitates return on investment tradeoff analyses. As a result training system design/development and acquisition decisions made with support of EVALS-R will lead to increased organizational training and readiness.

6.0 REFERENCES

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Bangor, A., Kortum, P., Miller, J. "Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale." Journal of Usability Studies, Vol. 4, No. 3, 2009.

7.0 APPENDIX A - Productivity

Conference presentation (Contributed):

Carroll, M., Champney, R., Padron, C., Wang, X., Haddad, D. Predictive Approach for Assessment of Return on Training Investment. International Test and Evaluation Symposium; 2014 November 12-15; Crystal City, Virginia.

8.0 APPENDIX B - Award Participants

People receiving salary support from the EVALS-R effort include Christina K. Padron, Roberto K. Champney, Zachary Huber, Michelle A. Sinagra, Jack L. Hart, David Mui, Denis Oliva Ramos, and Shauwn Rush.

LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS

EVALS-R	Evaluation of Value Added in Learning Systems
GUI	Graphical User Interface
RITE-MT	Return on Investment Tool for Effective Medical Training
ROTI	Return on Training Investment
SME	Subject Matter Expert
TEE	Training Effectiveness Evaluation
TNA	Training Needs Analysis